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## Analysis of profit contribution variance between actual and plan

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Nr. 332

**Sönke Albers**

**ANALYSIS OF  
PROFIT CONTRIBUTION VARIANCE  
BETWEEN ACTUAL AND PLAN**

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## **Abstract**

The traditional techniques of calculating quantity and price variances for analyzing deviations of realized profit contribution (actual) from the planned profit contribution only offer the benefit of identifying areas where problems may exist, rather than diagnosing the causes of these problems. Therefore, it is proposed to base profit contribution variance analysis on market response functions which have been assumed when fixing the planned marketing budgets, prices and quantities. This allows for a decomposition of total contribution variance into causal sources such as realization, effectiveness, reaction and planning variance. It is also shown how the variance of any such source can be separated into effects caused by exogenous factors as well as single market instruments.

## 1. Problem

An important task of marketing planning and control consists of analyzing deviations of realized profit contribution (actual) from the planned profit contribution for a firm's products. A product manager's performance can be evaluated using these deviations only if the sources of such deviations can be identified and their effects quantified. Traditionally, the well-developed techniques of identifying quantity and price variances for costs of production processes of manufactured goods have been applied to the explanation of sales variances (i.e. Hongren, 1967). These widely accepted accounting practices have subsequently been made more sophisticated by: a) splitting the price variance into a sales volume and sales mix variance, and the quantity variance into a yield and mix variance, and b) splitting the quantity variance into a market size and market share variance (i.e. Kaplan, 1982, p. 285 et seq.; Hulbert and Toy, 1977). The latter represents an attempt to isolate the impact of the total market (which might not be under the control of a product manager) from market share variations which constitute part of the product manager's performance.

Despite these refinements, this traditional approach has been criticized for neglecting price-quantity relationships. In fact, a negative price variance will always result after a price reduction but does not provide information on the profitability of such a decision. An answer to this problem can only be found if one calculates the increase of quantity following a price decrease, and then assesses the overall effect on profit. Hulbert and Toy (1977), therefore, note that the traditional approach offers only the benefit of identifying areas where problems may exist rather than diagnosing the causes of these problems. Even worse, independently derived quantity and price variations may be misleading for drawing conclusions. Consequently, Manes (1983) proposes to estimate the ex post elasticity from a sales and price variation in order to determine whether or not this price variation was headed in the right direction as indicated by optimal prices from economic theory. Unfortunately, this proposal breaks down if revenue variances result not only from price variations but also from advertising budget and distribution rate variations. In this case, it is impossible to calculate ex post elasticities for several marketing instruments on the basis of just one sales variation observation. In order to resolve these problems it is proposed here to base profit contribution

variance analysis on a market response function which has been either implicitly or explicitly assumed when fixing the planned budgets, prices and quantities. This allows for a decomposition of total contribution variance into causal sources such as the deviation of marketing actions from those which were planned (realization variance), the effectiveness of the use of marketing budgets (effectiveness variance), the effect of competitive reactions (reaction variance), and the effect of having worked with either incorrect or incomplete planning assumptions. Moreover, it is herein shown how the variance of any such source can be separated into effects caused by single marketing instruments. This information enables a firm to judge the degree to which the decisions made by a product manager and the way such decisions were implemented have been advantageous, and for what part of the total contribution variance he can be held responsible.

Section 2 discusses in more detail why the traditional approach may be misleading in explaining profit contribution variances, and identifies questions on which a "causal" variance analysis should offer quantitative answers. Section 3 presents the kind of response functions necessary for the proposed approach, while section 4 describes the basic principles of the decomposition of revenue variance into various sources with the help of response functions. Section 5 extends this analysis to a profit contribution variance analysis by taking into account all cost variations caused by marketing actions. This is followed, in section 6, by a discussion of how to calibrate the required response functions. The value of the proposed approach is then illustrated with the help of an example in section 7. The paper closes with concluding remarks on the applicability of this new approach.

## **2. Information Needed from Profit Contribution Variance Analysis**

To begin our analysis let us consider the following simple case given in table 1.

< please insert table 1 somewhere here >

If one follows the traditional approach one obtains the following information:

Price Variance	= (16-20) * 1,000,000	= - 4 Mio Ecu
Quantity Variance	= (1.5 Mio-1.0 Mio) * (20-10)	= +5 Mio Ecu
Price-Quantity Variance	= (16-20) * (1.5 Mio-1.0 Mio)	= - 2 Mio Ecu
Budget-Variance	= - (1,000,000 - 2,000,000)	<u>= +1 Mio Ecu</u>
		0

On the basis of these figures a controller would probably come to the following conclusions. Overall, performance has remained constant. There is a problem with the price which may be overcompensated by the positive quantity variance. In addition, the marketing expenses have been reduced together with increasing revenue which, obviously, must have increased cost effectiveness. Any marketing manager would find such conclusions to be very strange. In fact, as table 2 shows, the conclusions depend heavily upon the assumed responsiveness of the marketing instruments:

< please insert table 2 somewhere here >

If the firm had assumed situation 1 then total expected sales (quantity, see column 3) equals actual sales, such that there is no deviation between actual and expectation (see column 5). However, the pricing decision itself was incorrect since it lowered the resulting profit contribution before marketing costs by 1.0 Mio Ecu compared to plan (see column 6). The assessment would change if the firm had assumed a higher price elasticity. In situation 3 the price reduction might have been a good idea (column 6) but in reality the achieved quantity did not meet the expectations (column 5), such that either the price elasticity was wrong or the other marketing-mix-instruments proved to be ineffective. Analogous conclusions can be drawn with respect to advertising (see table 2). This example demonstrates the need for a market response function as a basis for decomposing a profit contribution variance into various sources.

In addition, in order to learn something about the effectiveness of the different marketing instruments, the marketing controller wants to know whether contribution variances are due

to changes within the non-controllable market or due to actions of a certain product manager. This enables outside people to better evaluate the performance of a product manager.

Furthermore, the controller is interested in knowing whether variations of marketing instruments between actual and planned would have been good decisions under the planning assumptions. He also wants to understand the impact that competitive actions (or reactions) have on the profit contribution variance.

Of even more value is information regarding whether the planning assumptions (i.e. elasticities) have been correct or not. However, this question cannot be answered by only one observation of sales (see critique on ex post elasticities with respect to Manes). Rather, one would have to estimate actual elasticities from cross-sectional panel data (across brands in the market) with appropriate econometric methods. This is only feasible if the marketing instruments have varied sufficiently which is not generally the case.

### **3. Response Functions as a Basis for Profit Contribution Variance Analysis**

As argued above, any analysis on the effectiveness of marketing actions must be based on an idea of how sales quantity depends on marketing instruments such as price, advertising and distribution. Adhering to our goal of distinguishing between exogenous effects of the entire market and endogenous effects of the firm's own marketing-mix, we have to base our analysis on two different response functions. One relates market size to exogenous factors, but also to the average industry price and the industry marketing effort with respect to advertising and distribution. The other one functionally explains how market share depends on marketing-mix levels. The latter can be refined by decomposition into two stages. In the first stage one can model the direct response to the use of marketing budgets, i.e. awareness rate as a function of the advertising budget or distribution rate as a function of the distribution budget. In the second stage the relative impact of price, awareness rate and distribution rate (as compared to the industry) determines market share. If the data is insufficient, one can also directly relate market share to various shares of budgets. Fig. 1 gives an overview of the

various relationships for which response functions have to be developed in order to be able to estimate sales quantity.

< please insert fig. 1 somewhere here >

For the purpose of expository simplicity, we will describe the idea of the proposed profit contribution variance analysis (PCVA) using one specific type of response function, namely the multiplicative form. This is a very popular and widely accepted functional form among marketing researchers. It offers the properties of diminishing marginal returns and parsimony with respect to the number of parameters (Naert and Leeflang, 1978, pp. 74 et seq.; Hanssens, Parsons and Schultz, 1990, p. 38). However, the principles of the proposed PCVA are universal and can be applied to any other form of response function. Furthermore, we will facilitate notation of the response functions by considering only the three basic marketing instruments of price, advertising and distribution. It should be noted, however, that the multiplicative form allows the incorporation of an arbitrary number of additional marketing instruments. We will initially concentrate on short-term response functions, and later relax this condition. With these qualifications in mind we begin our description of response functions with the first stage:

$$(1) \quad AW = AW_R \cdot \left( \frac{AB}{AB_R} \right)^\beta$$

$$(2) \quad DR = DR_R \cdot \left( \frac{DB}{DB_R} \right)^\gamma$$

AW: awareness rate  
 AB: advertising budget  
 R: index for reference values  
 $\beta$ : advertising budget elasticity

DR: distribution rate  
 DB: distribution budget  
 $\gamma$ : distribution budget elasticity

With response function type (1) and (2) we have chosen a somewhat different form than the well known multiplicative form  $y = \alpha \cdot x^\beta$ . It can easily be seen, however, that by setting  $\alpha = AW_R \cdot AB_R^{-\beta}$ , function (1) is equivalent to the multiplicative form. The reasons for choosing this functional form (as given in (1)) are the following:

- It can better be subjectively estimated, as  $\beta$  can directly be inferred from  $AW$ ,  $AW_R$ ,  $AB$ , and  $AB_R$  (see formula (7)),
- there is no necessity to estimate a scaling constant,
- expressing variations of the dependent variable relative to a reference value depending on relative variations of an independent variable (relative to a reference value) is intuitively better understandable by managers,
- the function explicitly passes through the current values if reference values are representing current values which also increases managerial acceptance.

A similar function as (1) and (2) has also been proposed in BRANDAID in order to be able to better separate the effects of multiple independent variables (Little, 1975, pp. 635 et seq.).

In the second stage, market share based on quantity units can be expressed as follows:

$$(3) \quad MS = MS_R \cdot \left( \frac{RP}{RP_R} \right)^a \cdot \left( \frac{SA}{SA_R} \right)^b \cdot \left( \frac{SD}{SD_R} \right)^c$$

MS: unit based market share

RP: relative price defined as price divided by average industry price

SA: share of advertising defined as awareness rate divided by the sum of awareness rates of all firms in the industry

SD: share of distribution defined as distribution rate divided by the sum of distribution rates of all firms in the industry

R: index for reference values

a,b,c: elasticities of relative price, share of advertising, and share of distribution, respectively.

Finally, total market size can be explained by:

$$(4) \quad TM = TM_R \cdot EXO \cdot \left( \frac{AIP}{AIP_R} \right)^A \cdot \left( \frac{SAW}{SAW_R} \right)^B \cdot \left( \frac{SDR}{SDR_R} \right)^C$$

TM:	total market size (in units)
R:	index for reference values
EXO:	variable representing exogenous effects such as population or economic conditions
AIP:	average industry price
SAW:	sum of awareness rates of all firms in the industry
SDR:	sum of distribution rates of all firms in the industry
A,B,C:	elasticities of industry activities, respectively.

#### 4. Basic Principle of Decomposing the Revenue Variance into Causal Effects

As outlined above, traditional approaches split revenue into the three multiplicatively related components of price, market share (unit based) and market size (unit based), and then calculate the effects of deviations on revenue. This only provides information on symptoms but does not offer insight as to the causes of these effects. Because we want to get information regarding the part of the variance for which the product manager is responsible, it is here proposed to separate the exogenous influence of the market from the consequences of our firm's actions (endogenous factors). This is made possible by the decomposition of revenue into (volume based) market share, which is mainly endogenously influenced, and market volume, which is mainly exogenously influenced (Fig. 2).

< please insert fig. 2 somewhere here >

The endogenously influenced revenue variance can further be decomposed into the following causes which can best be illustrated for the marketing instrument *advertising* (see fig. 3):

< please insert fig. 3 somewhere here >

- a) We can first calculate the part of the revenue variance called realization variance, which occurs as a result of choosing an actual advertising budget different from the planned one. If we investigate this on the basis of the planning assumptions or, more precisely, the assumed response functions (see fig. 2) we then learn about the usefulness of the decision itself. This can be achieved by plugging the actual advertising budget into the awareness response function, giving us the expected awareness level  $AW_E$  for the actual advertising budget  $AB_A$ . If we assume that the competition remains at planned awareness, we can calculate our firm's share of advertising  $SA_E$  via  $AW_E$  divided by the sum of the awareness levels planned for all firms in the industry ( $SAW_P$ ), and look at the market share  $MS_E$  corresponding to this share of advertising level. If, finally, one weights the deviation between  $MS_E$  and the planned  $MS_P$  with the planned relative price  $RP_P$  and the planned market volume  $MV_P$ , one arrives at the so-called realization variance.
  
- b) In reality, observed and expected awareness levels are not the same, because the qualitative effectiveness of a campaign may vary. The resulting revenue variance of this difference represents an effectiveness variance. This figure can be obtained by calculating the market shares  $MS_O$  and  $MS_E$  for the observed relative share of advertising level ( $SA_O = AW_O / SAW_P$ ) and the expected relative awareness level ( $SA_E = AW_E / SAW_P$ ) via the response function, assuming for both levels planned awareness levels for all competitors. Now, the difference between  $MS_O$  and  $MS_E$ , weighted with the expected relative price  $RP_E = P_A / AIP_P$  and the planned market volume  $MV_P$ , gives the effectiveness variance. A negative value for such a variance indicates that either the media-selection, the copy or the timing has not been executed effectively. Here, the product manager is responsible for all three causes.
  
- c) In the case of reactions by competitors, it is not the market share  $MS_O$  but  $MS_F$  that results as a forecast from the application of the response functions.  $MS_F$  is the market share holding for the actual share of advertising level  $SA_A = AW_A / SAW_A$ . The difference from  $MS_F$  to  $MS_O$  provides information on how much one was hurt by competitive reactions. If one weights the deviation between  $MS_F$  and  $MS_O$  with the expected relative

price  $RP_E$  and the planned market volume  $MV_P$ , one obtains the part of the revenue variance which is due to competitive reactions and called reaction variance. This part of variance is generally considered beyond the control of a product manager. However, other managers argue that a product manager is also responsible for good forecasts of competitive reactions, and would indeed allot this form of variance to the product manager's responsibility.

- d) If another market share  $MS_A$  is actually holding, then the difference to the forecasted  $MS_F$  is an indication that either the planning assumptions (in form of the response functions) have been incorrect or that the effectiveness of other marketing instruments not modelled in the response functions has been changed. In both cases we have to face a planning error. The part of the revenue variance which is due to this error is called planning variance. It can be calculated by multiplying the difference between  $MS_A$  and  $MS_F$  with the actual relative price  $RP_A$  and the planned market volume  $MV_P$ .

The discussion so far has been illustrated for one single marketing instrument, namely advertising. The same decomposition principle can be applied for the other marketing instruments, including price. However, when analyzing revenue variances that are due to price deviations we face some particular considerations. For non-price marketing instruments we obtain volume based market share variance by weighting (multiplying) a) the unit based market share realization variance  $MS_E - MS_P$  with the planned relative price  $RP_P$ , b) the effectiveness variance  $MS_O - MS_E$ , as well as the reaction variance  $MS_F - MS_O$ , with the expected relative price  $RP_E$ , and c) the planning variance  $MS_A - MS_F$  with the actual relative price  $RP_A$ . This means that we assume (at least conceptionally) the existence of sequentially related sources of variance where all marketing instruments are at respective values of the predecesing status (i.e. expected), when analyzing the variance of one instrument caused by variation due to the succeeding source (i.e. observed). If we now consider price we do not consider an effectiveness variance, since price directly affects market share (one-stage response). Consequently, we have to weight the unit based market share realization variance  $MS_E - MS_P$  with  $RP_E$  because it is just the influence of  $RP_E$  that we want to analyze. Analogously, we have to weight the reaction variance  $MS_F - MS_O$  with  $RP_A$ . If the effects caused

by the entire marketing-mix are taken into consideration, we have to weight the variances as described for price alone, because price is part of the marketing-mix. The volume based market share variance can, then, be graphically described as in fig. 4. Please note that market share and relative price are positively correlated only in this figure in order to allow for graphical representation. In general, we find a negative correlation leading to negative variances which, unfortunately, can only be expressed analytically.

< please insert fig. 4 somewhere here >

In the case of multiplicative response functions as assumed here, the isolated market share differences due to the variation of single marketing instruments do not add up to the total difference caused by the corresponding marketing-mix variation. This can be dealt with by introducing a residual mix variance compensating for this difference.

So far we have analyzed differences of volume based market shares due to deviations between actual and plan. In order to arrive at the corresponding revenue variances we have to multiply volume based market share differences with the appropriate market volume figures. As market volume is affected via market size (in units) by the same variables as market share (but not in the same way; see response functions (3) and (4)), the same variance sources as discussed under (a) - (d) can cause corresponding market volume differences. Combining the corresponding volume based market share and market volume differences, one can decompose total revenue variance as seen in fig. 5. However, it should be noted that the extent of the spatial representation does not give an indication of the magnitude of the corresponding revenue variance, but has been chosen to facilitate readability of the graphic. In reality, most of the variance areas are relatively small compared to the area representing planned revenue.

< please insert fig. 5 somewhere here >

## 5. From Revenue to Profit Contribution Variance Analysis

The proposed approach for revenue variance analysis already provides detailed and valuable information on the effectiveness of certain marketing actions. If we go further and wish to analyze the profitability of deviations between planned and actual marketing efforts, we have to calculate the corresponding costs of all evaluated marketing-mix policies and subtract them from revenue. As we are only interested in cost variances due to marketing decisions, we can restrict our attention to the marketing budgets for advertising, distribution and unit cost.

In general, unit cost differences between actual and plan can be attributed to the production department and are here, therefore, treated as exogenous sources of profit contribution variance. In some situations, however, a product manager may argue that a marketing policy leading to an increased number of sales units will also have caused economies of scale and/or experience curve effects which can be attributed to the marketing policy. Therefore, we assume a functional relationship between unit cost and quantity of the following simple type:

$$(5) \quad C = C_R \cdot \left( \frac{Q}{Q_R} \right)^\delta$$

- C: unit cost
- R: index for reference value
- Q: quantity (as given by unit based market share \* market size)
- $\delta$ : economies of scale and/or experience curve elasticity

Because each component of the revenue variance consists of the difference between two revenue figures explicitly given by quantity (= market share (unit based) \* market size) multiplied by price (= relative price \* average industry price), it is possible to calculate the corresponding costs for each revenue situation. With this basis, one can calculate the profit contribution variance as follows:

- (6) profit contribution variance = revenue variance
- marketing budget variance
  - unit cost variance due to economies of scale
  - unit cost variance due to improved production efficiency (exogenous)

## 6. Data Availability and Disclosure of Planning Assumptions

From the previous sections we have learned that the proposed approach offers a detailed analysis of various sources of profit contribution variance. However, this type of analysis requires somewhat more data than just price and quantity, which are the two required for the traditional approach. Moreover, our approach is based on response functions, requiring the disclosure of planning assumptions (i.e. elasticities). Unfortunately, the majority of this data is not available from internal accounting sources. While prices and budgets are internally retrievable, other data must be procured from outside sources.

For consumer products, a firm usually subscribes to panel data providing the firm with quantities, market shares, prices and distribution rates for itself and for all competitors. Based on one's own market share and the internally known sales quantity, market size can easily be inferred. In addition, market research companies offer the service of tracking studies on direct response measures of advertising such as awareness, recall, etc. If this option is judged to be too expensive, the firm may purchase data on advertising budgets for all competitors from such companies as A.C. Nielsen Advertising Service.

For durables or standardized industrial goods such as copy-machines or computers (for which panel data may not be available), the firm must either rely on industry associations' reports or acquire data on quantities and prices from market research companies. Advertising budget data may be purchased from the same sources as described above. Distribution is much more a problem of personal selling for industrial companies. Here, some market research companies offer provision of reports on the number of salespersons of all competitors in the field. This figure can be viewed as a rough measure of a personal selling budget.

In addition to this data the planning assumptions must be made explicit, which means a calibration of the underlying response functions. More precisely, the elasticities which have intuitively, if not intentionally, been used in the demand for certain (planned) revenue or profit contribution figures must be disclosed. This can be achieved, in principle, in two different ways.

If sufficient historical and/or cross-sectional data exists, one may estimate the elasticities of the response functions statistically. Panel data offers, in most cases, this opportunity. This way is recommended if it is at all possible, as the firms acquire market response knowledge that can constitute competitive advantages. Once the elasticities are known the planning process is no longer arbitrary, such that one can only specify planned revenue or profit contribution figures if these can actually be achieved through the planned marketing actions according to the response functions. This offers the additional advantage that planned output will always be realistic.

If statistical estimation of the elasticities does not prove applicable, we have to rely on subjective estimates. This does not necessarily imply a weakness of the approach. Indeed, the planning authority has based his plan on an intuitive estimate of the market response anyway. Therefore, it is proposed here to infer the elasticities he assumed from a comparison of planned sales and marketing-mix with past sales and marketing-mix as reference values. This is feasible if market conditions have not varied too much. If the latter is the case, past values must be corrected so that they reflect appropriate reference values. With respect to the budget elasticities and the economies-of-scale elasticity, the inference is straight forward - by solving the response functions (1), (2), and (5) for the unknown elasticities:

$$(7) \quad \beta = \frac{\ln(AW_P/AW_R)}{\ln(AB_P/AB_R)}$$

$$(8) \gamma = \frac{\ln(DR_P/DR_R)}{\ln(DB_P/DB_R)}$$

$$(9) \delta = \frac{\ln(C_P/C_R)}{\ln(Q_P/Q_R)}$$

- AW: Awareness level

AB: Advertising budget

DR: Distribution rate

DB: Distribution budget

C: Unit cost

Q: Quantity
- P: index for planned values

R: index for reference values  
(generally past values)

A direct inference of the elasticities of market share response function (3) and market size response function (4) is not possible because the dependent variables depend on several independent variables of the marketing-mix, while the elasticities correspond to the isolated effect of single independent variables. Therefore, the planning authority is asked to provide the following subjective estimates for unit based market share MS (according to response function (3)) and market size TM (according to reponse function (4)), where one variable is at planned value (index: P) while the other variables are at reference values (index: R), respectively. Let us denote these estimates as follows:

Subjective estimates for unit based market share	Subjective estimates for unit based market size
MS (RP <sub>P</sub> , SV <sub>R</sub> , SD <sub>R</sub> )	TM (AIP <sub>P</sub> , SAW <sub>R</sub> , SDR <sub>R</sub> )
MS (RP <sub>R</sub> , SV <sub>P</sub> , SD <sub>R</sub> )	TM (AIP <sub>R</sub> , SAW <sub>P</sub> , SDR <sub>R</sub> )
MS (RP <sub>R</sub> , SV <sub>R</sub> , SD <sub>P</sub> )	TM (AIP <sub>R</sub> , SAW <sub>R</sub> , SDR <sub>P</sub> )

All elasticities can then be infered similar to (7), (8), and (9) which will be exemplified for MS (RP<sub>P</sub>, SV<sub>R</sub>, SD<sub>R</sub>):

$$(10) \quad a = \frac{\ln (MS(RP_P, SV_R, SD_R) / MS_R)}{\ln (RP_P / RP_R)}$$

This inference mechanism allows for various plausibility tests. First of all, the inferred elasticities can be compared with values in comparable cases or results from meta-analysis studies (i.e. Assmus, Farley and Lehmann, 1984; Tellis, 1988). Second, if one calculates planned market share  $H(MS_P)$  and market size  $H(TM_P)$  by taking all independent variables at their planned values, then the resulting  $H(MS_P)$  and  $H(TM_P)$  should not be different from the originally planned  $MS_P$  and  $TM_P$ . If, however, inequality persists, either the originally planned values for  $MS_P$  and  $TM_P$  or the assumed elasticities must be incorrect and need to be corrected until planned values and assumed elasticities are consistent for the entire marketing-mix.

## 7. Application of the Profit Contribution Variance Analysis

The information value of the proposed analysis approach can best be demonstrated with the help of an example. Let us, therefore, consider the following situation as described in table 3.

< please insert table 3 somewhere here >

Here, the product manager was given a plan that requested a price decrease from 430 Ecu to 420 Ecu, an advertising budget decrease from 200,000 Ecu to 150,000 Ecu, and a distribution budget increase from 400,000 Ecu to 500,000 Ecu. This plan should have improved profit contribution from -60,000 Ecu to +110,000 Ecu. Actually, the product manager decreased the price even more, to 410 Ecu, and decided to reallocate the budget from distribution to advertising by increasing the advertising budget to 400,000 Ecu and decreasing the distribution budget to 300,000 Ecu. He was lucky and achieved almost exactly the planned profit contribution of 110,000 Ecu. Does this mean that everybody has been satisfied and the controller

can dispense with a detailed analysis? Doubts are in order here, because the product manager only achieved a volume based market share of 9.3 % instead of the planned 10.0 %, while taking advantage of an actual market volume of 18,781,832 Ecu instead of the planned 16,800,000 Ecu. As pointed out above, any variance analysis must be based upon response functions. Table 4, therefore, demonstrates the inferred elasticities.

< please insert table 4 somewhere here >

Based on these elasticities, the effects of the marketing-mix decisions on unit based market share and market size can be calculated from response functions (1), (2), (3), (4), and (5). The results are given in tables 5 and 6.

< please insert table 5 and 6 somewhere here >

By only considering the market share figures (see table 5) as predicted from the response function for the actual marketing-mix levels we see that the product manager would have achieved only a slightly higher "expected" market share (10.17%) but at the expense of a lower price and a higher total marketing budget. Because of an obviously noneffective use of the advertising budget one would have observed an even lower "observed" market share (9.57%) which remains uncompensated by effective use of the distribution budget (10.55%). Since the competitors, too, have decreased their prices and achieved overall higher awareness and distribution rates, the controller should have predicted a "forecasted" market share of only 8.72 %. Fortunately, the actual market share was higher (9.10 %), pointing either to incorrect planning assumptions or un-modelled marketing instruments. While the marketing-mix of the product manager under investigation had no effect on market size, a significant increase of market size (43,214 units), which was actually even higher (46,848 units), could have been forecasted. This leads to the tentative conclusion that the product manager would not have achieved planned contribution with his decisions. He was saved only by an unforeseen increase of market size. This qualitative analysis can be quantified by relating market shares and market sizes to contribution figures and calculating the deviations between various situations. Performing such an analysis according to section 4 and 5 gives us the following

detailed contribution variances (see table 7).

< please insert table 7 somewhere here >

From the total variance, decomposed into instruments and causes as shown in table 7 (last submatrix), one can conclude that the price decrease was a good decision (+11,417 Ecu contribution) if competitors had not reacted. If their actual price decrease had been a retaliation, the overall result of the decision of the product manager would have to be evaluated negatively (-21,960 Ecu contribution) compared to planned values. The reason for this is that the decreased price heavily influenced the market share but not market size (see upper two submatrices in table 7).

Increasing the advertising budget from 150,000 to 400,000 Ecu did not prove profitable (-621,264 Ecu contribution) under planning assumptions (realization variance). The advertising elasticity is too low to achieve substantial market share and market volume gains. Unfortunately, the product manager was unsuccessful with his campaign because the product achieved lower awareness levels than those predicted by the response function. This resulted in an additional -57,105 Ecu loss compared to plan. Even worse, the competition increased its sum of awareness rates, accounting for another -5,520 Ecu contribution loss.

Here, the interaction terms (see third submatrix) show relatively high values because they make up for the fact that the budget is subtracted from the contribution variances twice: from the ones resulting from market share deviations as well as those resulting from market volume deviations.

Decreasing the distribution budget from 500,000 to 300,000 Ecu proved to be profitable. The loss of market share was less severe than the budget savings (+460,314 Ecu contribution). This is even more true for market size. Despite reducing the budget, the product manager was able to maintain the distribution rate better than predicted from the response function. This accounted for a +37,114 Ecu variance. These positive values are diminished by the competition's increase of the sum of distribution rates (reaction variance: -10,110 Ecu).

Overall, the reallocation of the budget towards advertising was a highly questionable policy.

As the separate effects of the various marketing instruments do not add up to the total effect because of the multiplicative response function, we have introduced a compensating term called "residual mix". More precisely, it is the difference between the total effect of all instruments and the sum of separate effects of all single instruments. Generally, its values are relatively small and can be neglected for interpretation except in cases where substantial interaction effects between marketing instruments occur.

Overall, the marketing-mix actually chosen must be evaluated negatively. Under planning assumptions a realization variance of -72,097 Ecu would have occurred. The budgets have not been used effectively, as indicated by the effectiveness variance of -22,635 Ecu. Finally, competitive actions explain an additional contribution (reaction) variance of -48,267 Ecu. Fortunately, the product manager achieved a higher market share than forecasted by the response function, indicating that either important marketing instruments were not modelled or the planning assumptions were incorrect (+80,528 Ecu). Furthermore, the market size developed much more advantageously than anticipated, resulting in a rather large planning variance of +108,583 Ecu.

The conclusion of this analysis is rather differentiated. Overall, the product manager has met planned contribution. However, he took advantage of the favorable development of market size while his own marketing decisions appear to be questionable. The detailed information of this analysis allows a controller to detect weaknesses in the planning process as well as in the execution of actions planned.

## **8. Limitations and Conclusions**

In this paper an approach for analyzing profit contribution variance between actual and plan has been proposed which identifies and quantifies causal sources rather than symptoms, as in the traditional approach. With only a little more data on planning assumptions than previous-

ly utilized, detailed information can be provided on the effect of having chosen marketing actions deviating from planned ones (realization variance), the effectiveness of the use of marketing budgets, the effect of competitive reactions, and the effect of having worked with either incorrect or incomplete planning assumptions. Moreover, total profit contribution variance can be decomposed, not only into the above mentioned sources but also into single causing marketing instruments. The main idea of this approach is to base the decomposition on response functions representing the planning assumptions. By distinguishing between a response function for market share and one for market size we are able to separate endogenously caused variances from exogenously influenced variances.

The approach is demonstrated with the help of simple multiplicative response functions. It is important, however, to note that the decomposition principle works with any other less popular response function, although it remains an open question whether the parameter values can be inferred as easily. While the proposed approach is chosen to be very general, more specific sources of variance can, theoretically, be isolated by the application of analogous rules.

The purpose of this article was to demonstrate the advantages of basing profit contribution variance analysis on response functions. In order to facilitate the discussion the approach proposed here neglected dynamics in market response and did not deal with the specific problems of product lines. Fortunately, these limitations do not appear to be severe. Dynamic response can be modeled in response functions via lagged variables. Using the Koyck transformation, long-run market share can be inferred from short-run market share by multiplying it by a marketing-multiplier, which, in turn, is given by  $1/(1-\text{carry-over-coefficient})$  (i.e. Lilien/Kotler/Moorthy, 1992, p. 664). Similarly, long-run market size may be calculated. The whole analysis may now be based on corresponding long-run variances. The only problem is that the actual carry-over-coefficient cannot be observed, but has to be estimated statistically from historical data. If one wants to perform variance analysis on the product line level, the traditional approach proposes calculation of a yield variance for the whole line and a mix variance for single products' deviations from the average. However, following the idea of the approach proposed here, it would be better to carry out the analyses on a disaggregate

level and incorporate substitution or complementary effects into the respective response functions in order to properly quantify the variance caused by interrelated marketing actions.

Overall, the approach suggested here provides much more information than the traditional approach while requiring only a little more data. This article shows that such additional data is, in general, available or can easily be obtained via subjective estimation. Here, as everywhere, the following conclusion holds: It is better to be vaguely right rather than to offer precise but useless information (Lodish, 1974). Even if one has different response functions or additional sources of variance in mind, this paper has likely opened up discussion on how to overcome shortcomings of the traditional approach to variance decomposition and will hopefully initiate a stream of helpful and implementable approaches.

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**Table 1: TRADITIONAL PROFIT CONTRIBUTION  
VARIANCE ANALYSIS**

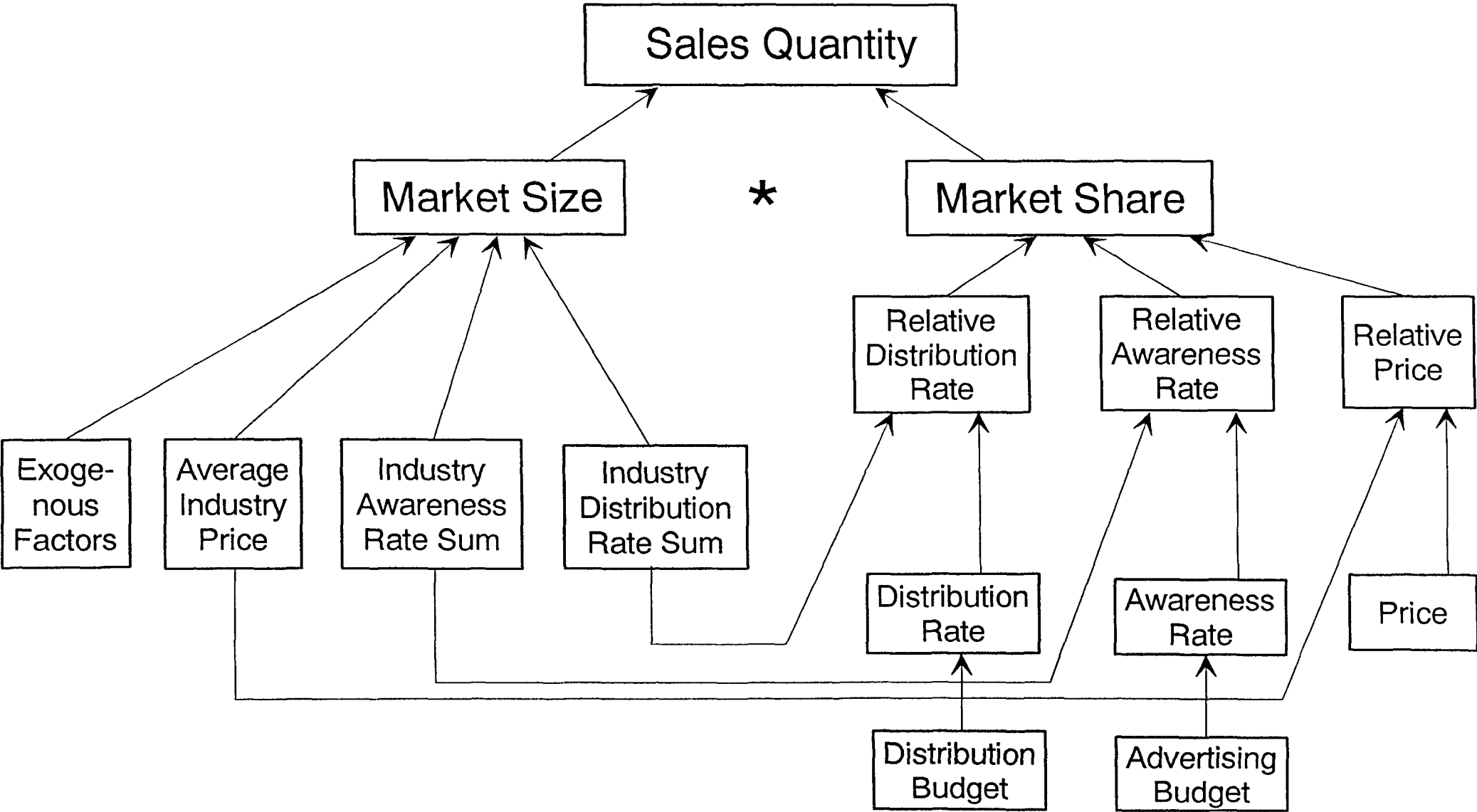
	Planned	Actual
Price	20	16
Quantity	1,000,000	1,500,000
Revenue	20,000,000	24,000,000
Cost per Unit	10	10
Total Cost	10,000,000	15,000,000
Contribution before Marketing Costs	10,000,000	9,000,000
Advertising Budget	2,000,000	1,000,000
Profit Contribution	8,000,000	8,000,000

**Table 2:**

**DIFFERENT PROFIT EXPECTATIONS DEPENDING ON ASSUMED ELASTICITIES**

①	②	③	④	⑤	⑥
Situation	Price elasticity	Expected quantity resulting from isolated price decrease  $1 \text{ Mio} * (1 + -20 \% * ②)$	Expected contribution before marketing costs  $③ * (16 - 10)$	Profit contribution variance between actual and expected  Actual - ④	Profit contribution variance between expected and plan  $④ - \text{Plan}$
1	- 2.5	1,500,000	9,000,000	0	-1,000,000
2	- 3.3	1,666,667	10,000,000	- 1,000,000	0
3	- 5.0	2,000,000	12,000,000	- 3,000,000	+2,000,000
	Advertising elasticity	Expected quantity resulting from isolated advertising budget decrease  $1 \text{ Mio} * (1 + -50 \% * ②)$	Expected profit contribution after marketing costs  $③ * (20 - 10) - 1 \text{ Mio}$	Profit contribution variance between actual and expected  Actual - ④	Profit contribution variance between expected and plan  $④ - \text{Plan}$
4	0.1	950,000	8,500,000	- 500,000	+ 500,000
5	0.2	900,000	8,000,000	0	0
6	0.4	800,000	7,000,000	+ 1,000,000	- 1,000,000

**FIG. 1: SYSTEM OF RESPONSE FUNCTIONS DETERMINING SALES QUANTITY**



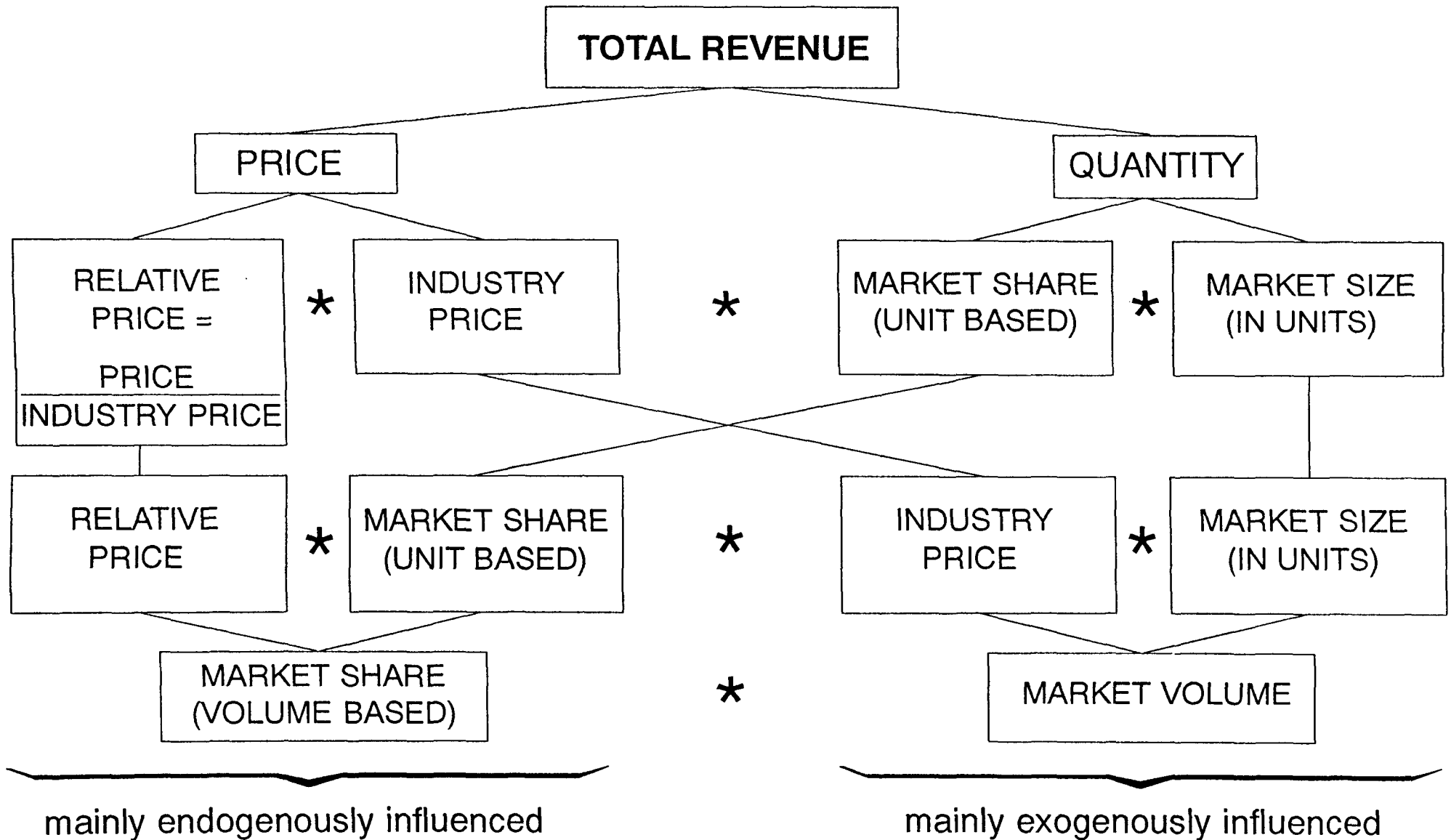
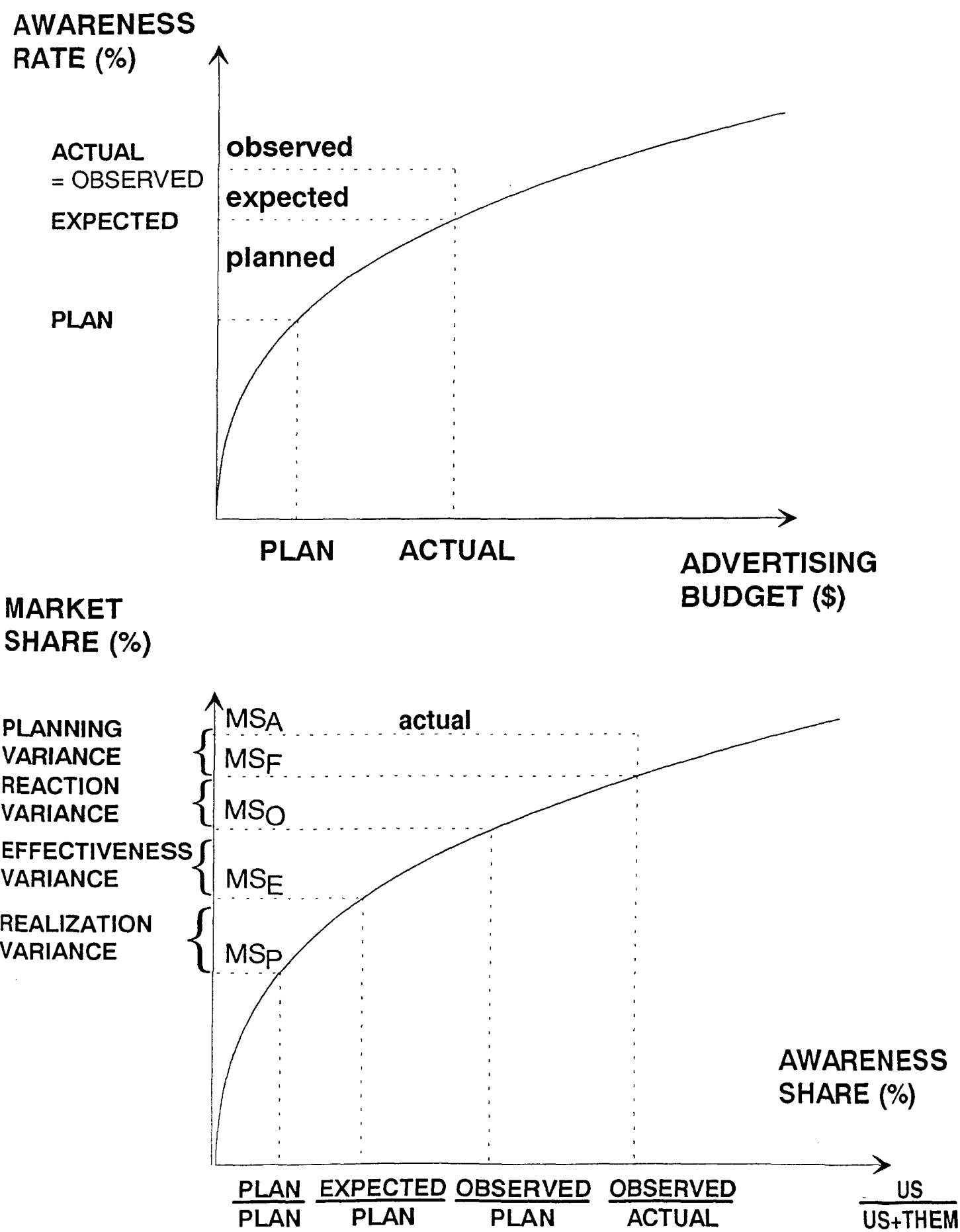


Fig. 2: Decomposition of total revenue into endogenous and exogenous components

**Fig. 3: DECOMPOSITION OF CAUSES OF VARIANCE WITH RESPECT TO ADVERTISING**



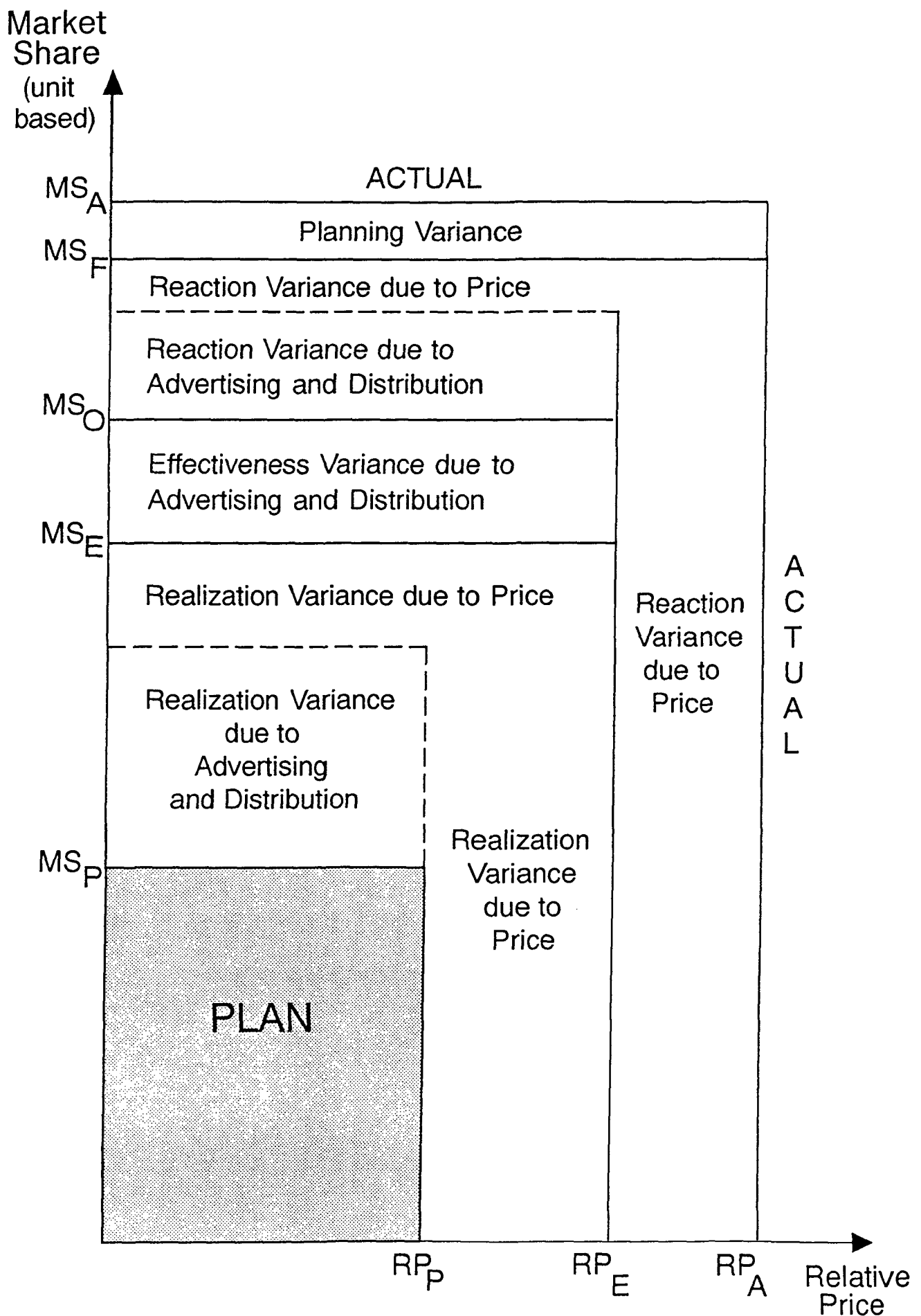


Fig. 4: Sources of Volume Based Market Share Variances caused by the marketing-mix or single marketing instruments

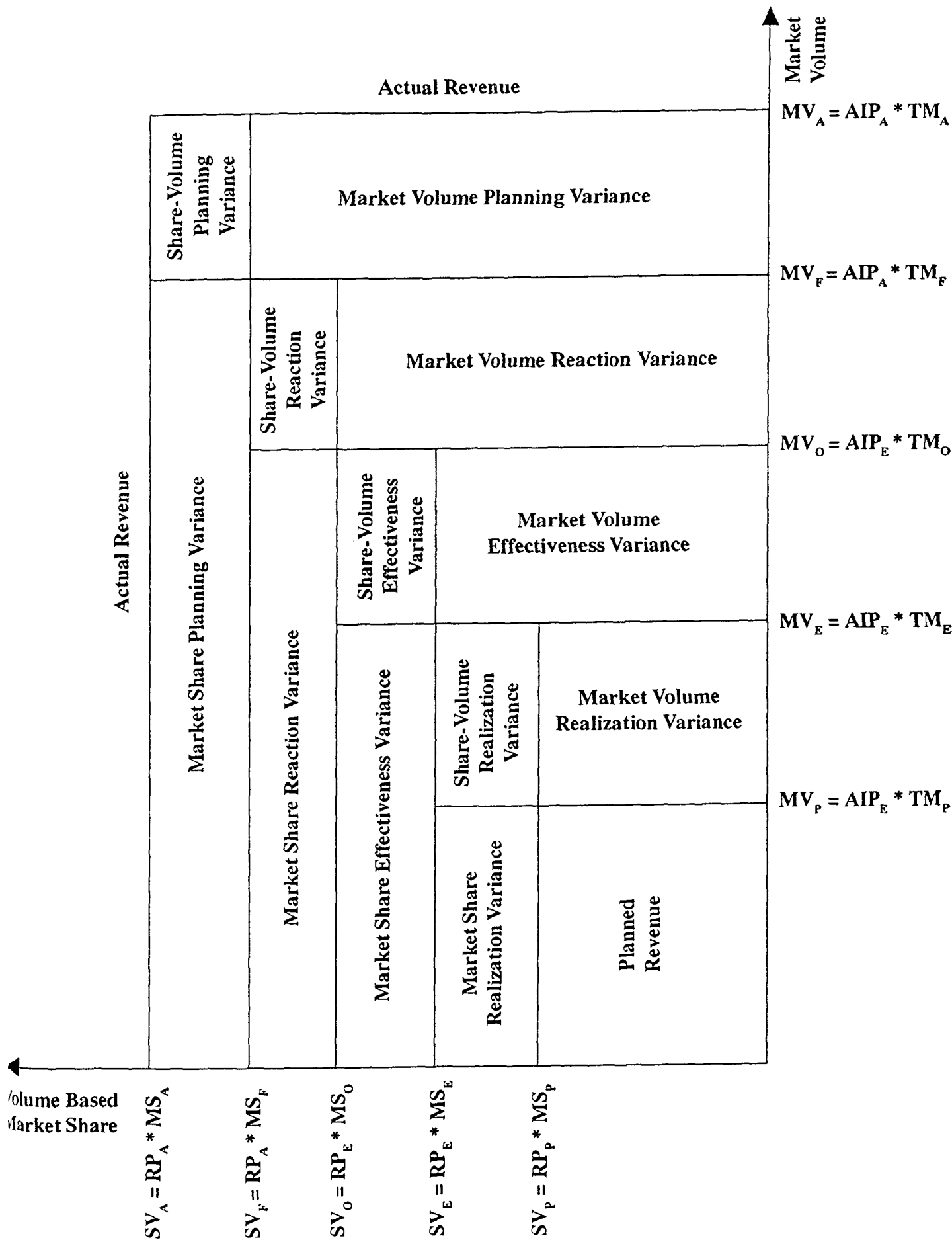


Fig. 5: Decomposition of total revenue variance into causal sources

	Reference	Plan	Actual
Price us	450	420	410
Price them	430	420	400
Average Industry Price	431.8	420	400.9
Relative Price	1.0421	1.0000	1.0227
Advertising Budget	200,000	150,000	400,000
Awareness us	33	29	36
Awareness them	270	280	290
Advertising Share	0.1089	0.0939	0.1104
Distribution Budget	400,000	500,000	300,000
Distribution us	48	54	44
Distribution them	450	460	475
Distribution Share	0.0964	0.1051	0.0848
Market Share (unit based)	9.0 %	10.0 %	9.1 %
Market Size (unit based)	30,000	40,000	46,848
Market Share (volume based)	9.4 %	10.0 %	9.3 %
Market Volume	12,954,000	16,800,000	18,781,832
Units	2,700	4,000	4,263
Revenue	1,215,000	1,680,000	1,747,899
Unit Cost	250	230	220
Total Cost	675,000	920,000	937,897
Contribution I	540,000	740,000	810,002
Total Budget	600,000	650,000	700,000
Contribution II	-60,000	110,000	110,002

Table 3: Planned and Actual Data for Product Sonal

**TABLE 4: INFERED ELASTICITIES**

	Reference		Plan		Elasticity
	Budget	Response	Budget	Response	
Advertising Distribution	200,000	33	150,000	29	0.4491
	400,000	48	500,000	54	0.5278
	Units	Unit Cost	Units	Unit Cost	
Production	2,700	250	4,000	230	-0.2121
	Instrument	Market Share	Instrument	Market Share	
Relative Price	1.0421	9.0 %	1.0000	9.9 %	-2.3330
Advertising Share	0.1089	9.0 %	0.0939	8.6 %	0.3055
Distribution Share	0.0964	9.0 %	0.1051	9.5 %	0.6275
	Instrument	Market Size	Instrument	Market Size	
Industry Price	431.8	38,000	420	39,600	-1.4885
Awareness Rate Sum	303	38,000	309	38,083	0.1113
Distribution Rate Sum	498	38,000	514	38,300	0.2487

Market Shares	Price	Advertising	Distribution	Mix
Plan				10.00 %
Expected	10.52 %	11.27 %	8.57 %	10.17 %
Observed	10.17 %	9.57 %	10.55 %	9.94 %
Forecasted	8.97 %	9.84 %	9.75 %	8.72 %
Actual				9.10 %

Table 5: Market share response on marketing instrument levels

Market Size	Price	Advertising	Distribution	Mix
Plan				40,000
Expected	40,142	40,226	39,751	40,117
Observed	40,117	39,992	40,172	40,046
Forecasted	42,751	40,185	40,339	43,214
Actual				46,848

Table 6: Market size response on marketing instrument levels

Table 7: ANALYSIS OF CONTRIBUTION VARIANCE

due to market share deviations resulting from	Realization Variance	Effective-ness Variance	Reaction Variance	Sub-total	Total
Price	12,082	0	-22,083	-10,001	Planning 80,528 -7,496
Advertising	-127,467	-54,368	-8,645	-190,480	
Distribution	65,287	35,777	-16,630	84,433	
Residual Mix	29,240	-2,426	1,209	28,023	
Subtotal	-20,858	-21,017	-46,149	-88,024	
due to market volume deviations resulting from					
Price	-618	0	-13,038	-13,656	Planning 108,583 +102,498
Advertising	-244,599	-2,937	3,160	-244,376	
Distribution	194,049	1,280	6,663	201,992	
Residual Mix	49,961	-5	-2	49,954	
Subtotal	-1,207	-1,661	-3,217	-6,085	
due to share-volume interaction deviations resulting from					
Price	-47	0	1,744	1,696	Planning -46,110 -95,000
Advertising	-249,198	199	-35	-249,034	
Distribution	200,978	57	-142	200,893	
Residual Mix	-1,765	-213	-467	-2,445	
Subtotal	-50,033	44	1,099	-48,890	
due to sum of share, volume and interaction deviations resulting from					
Price	11,417	0	-33,377	-21,960	Planning 143,001 2
Advertising	-621,264	-57,105	-5,520	-683,890	
Distribution	460,314	37,114	-10,110	487,319	
Residual Mix	77,436	-2,644	740	75,532	
Subtotal	-72,097	-22,635	-48,267	-142,999	